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Records of Air Shock Loading On A Three Dimensional Model

GLENN P. BEICHLER

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DEPARTMENT OF THE ARMY PROJECT Nos. 598-09-003 AND 503-04-002
ORDNANCE RESEARCH AND DEVELOPMENT PROJECT No. TB3-0112

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GPBeichler/ddh
Aberdeen Proving Ground, Md.
January 1954

RECORDS OF AIR SHOCK LOADING ON A THREE
DIMENSIONAL MODEL

ABSTRACT

Tracings are presented of the original records of air blast loading obtained in the 24-inch BRL shock tube on the front, top and rear surfaces of a rectangular shaped three-dimensional model. The records were obtained at incident shock pressures of approximately 3, 5 and 8 psi using a 2" x 4" x 2" "Oilite" model. Since essentially, the variations in loading are over in less than one millisecond the incident shock wave is a step shock.

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INTRODUCTION

A primary objective for the Ballistic Research Laboratories Shock Tube Facility has been to reduce to a routine operation the obtaining of accurate blast loading data on three-dimensional models. This has been done on a series of models for Ballistic Research Laboratories AFSWP Project 3.28.1. The results on the first model of this series are presented here. While the work presented here does not represent the ultimate perfection of the art nor even a fair example of the far more advanced present state of measurement techniques, it is a typical series of curves which may be useful to others in interpreting field data or theoretical work or, perhaps, in planning future model work for the shock tube. No analysis of the records is attempted; no conclusions are drawn.

EXPERIMENTAL PROCEDURE

The Model

The 2" x 4" x 2" model was made of "Oilite", a highly compressed powdered metal made of copper and tin and impregnated with oil, in an effort to achieve some internal damping and consequent reduction of vibration. One 2" x 4" face was instrumented with five piezoelectric pressure gauges as shown in sketch 1. The model could then be oriented in the shock tube as this instrumented face is normal to the shock front, side-on, or facing away from the direction of shock wave approach. The model was mounted on a large flat plate extending across the shock tube in such a way that leads from the five gauges could be readily brought out from the tube.

The Gauges

The one-half inch overall diameter piezoelectric gauges were constructed with 0.2" diameter tourmaline crystal elements. Complete description of gauge design and construction may be found in BRL Technical Note No. 860 by C. Benjamin Granath. Recording was accomplished with the eight channel Armour oscillograph which in addition provided calibration and time measurements.

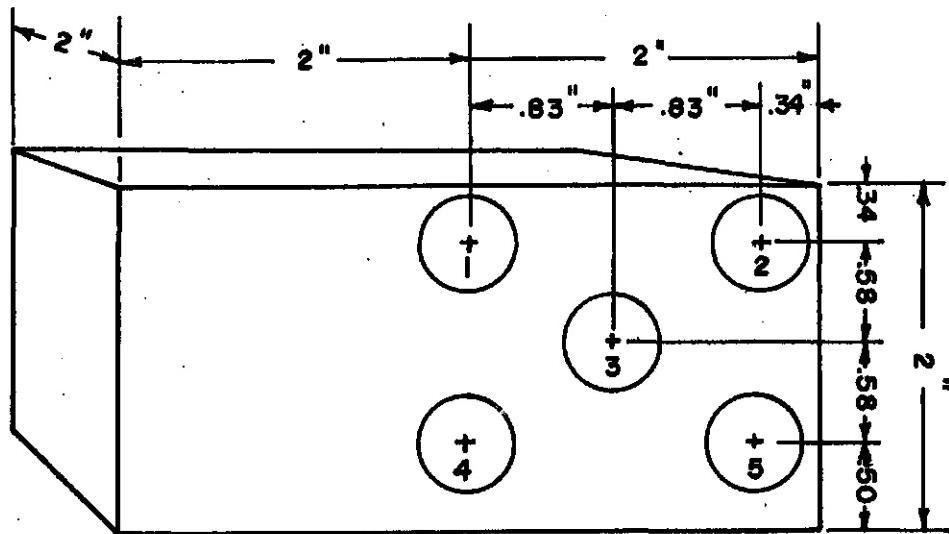
RESULTS

Pressure versus time curves are presented at five different points on the 2" x 4" front, top, and rear surfaces of a 2" x 4" x 2" three-dimensional model using incident step shock strengths of approximately 3, 5, and 8 psi. The position at which the pressure-time curve was taken is indicated in the little sketch adjacent to each curve. Incident pressure is also indicated for each curve as P_1 . For the short times presented, the incident pressure is essentially a constant. Rough pressure and time coordinates are indicated. Timing marks are in milliseconds. More precise measurements may be made by using the pressure and time factors given for each curve. For the pressure-time curves for the model top positions

the direction of approach of the shock wave is denoted by an arrow on the diagram and the approximate time of arrival of the shock at the front face is shown on the pressure-time curve with a caret (^).

GLENN P. BEICHLER

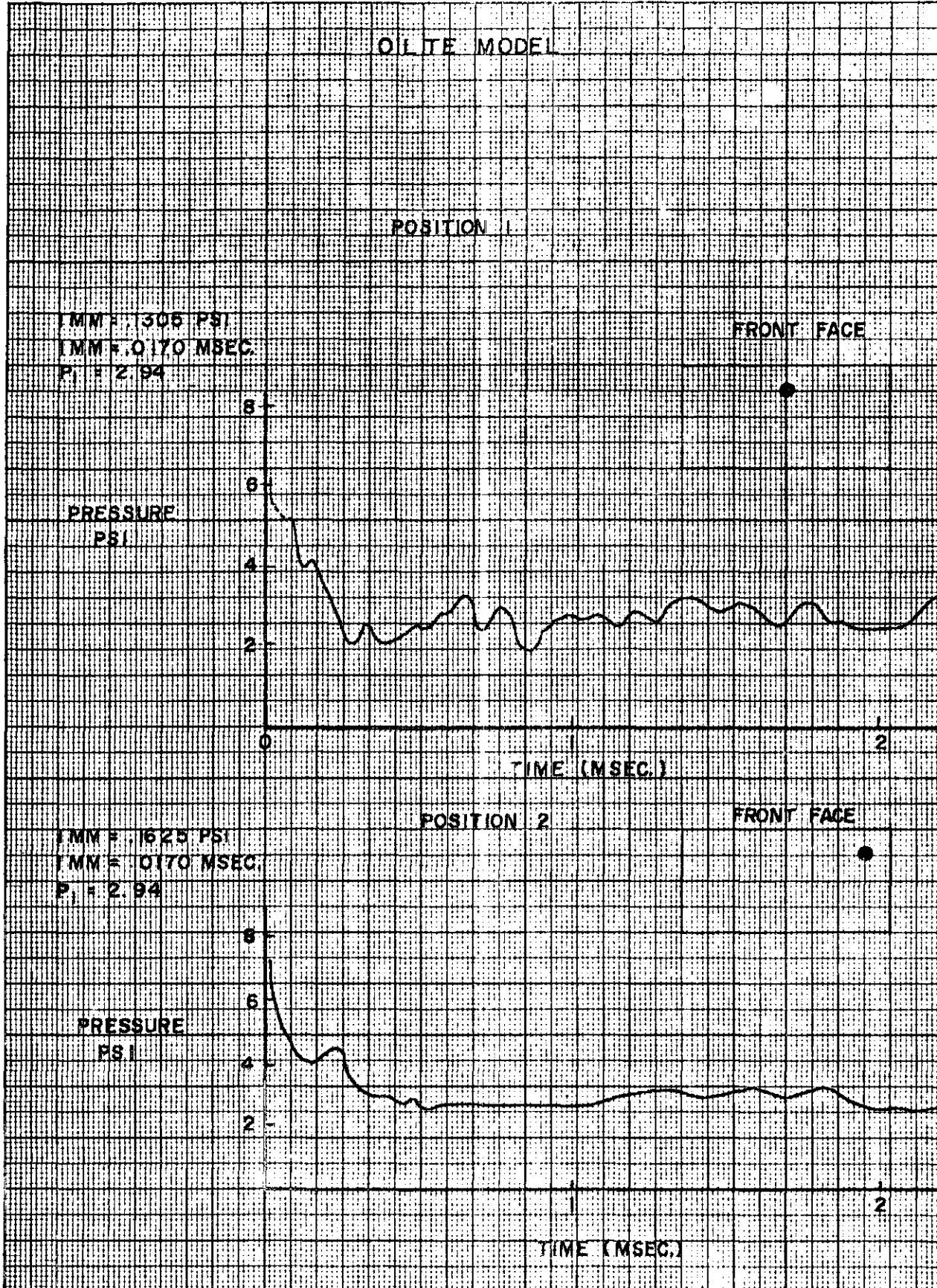
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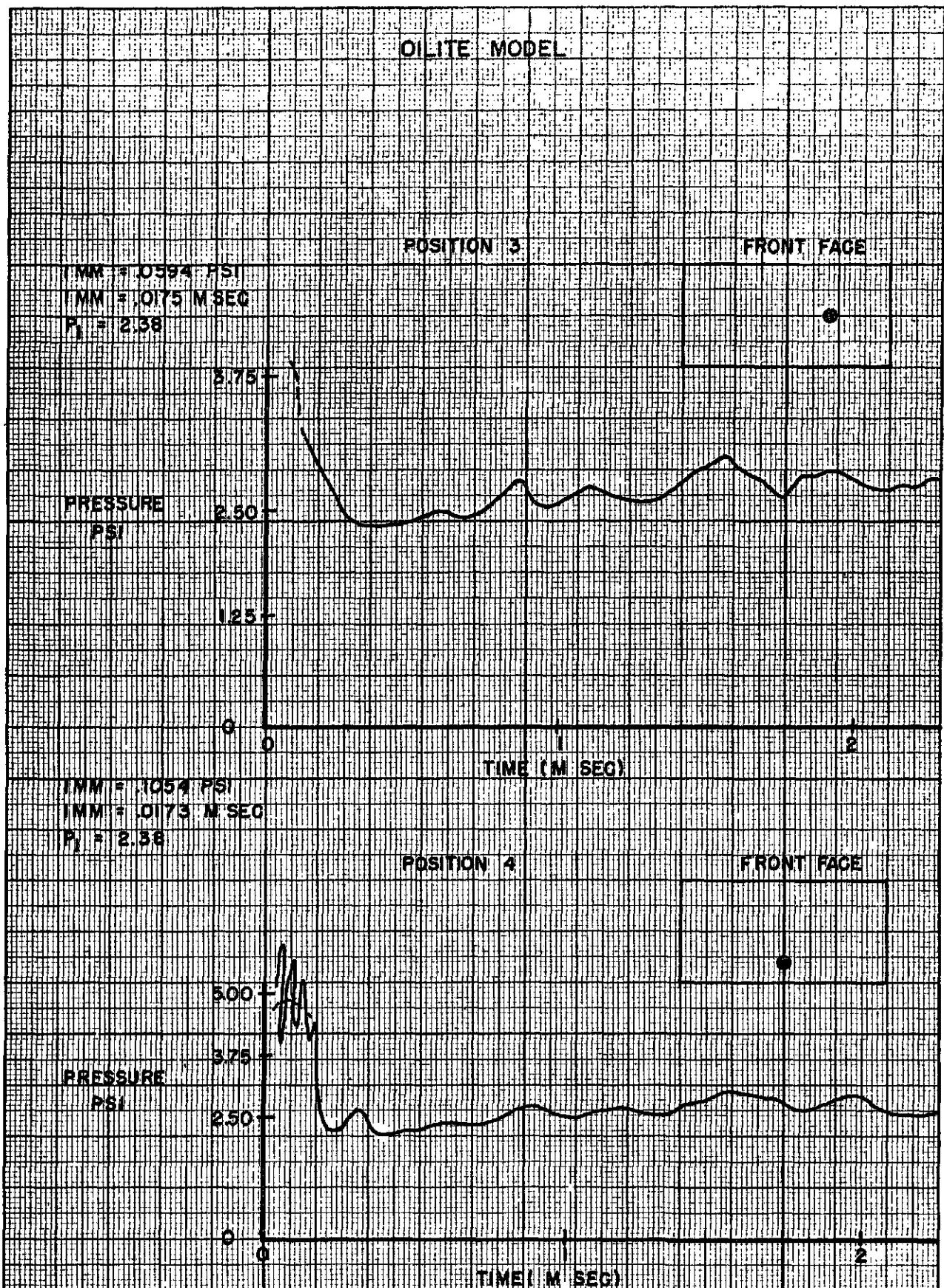


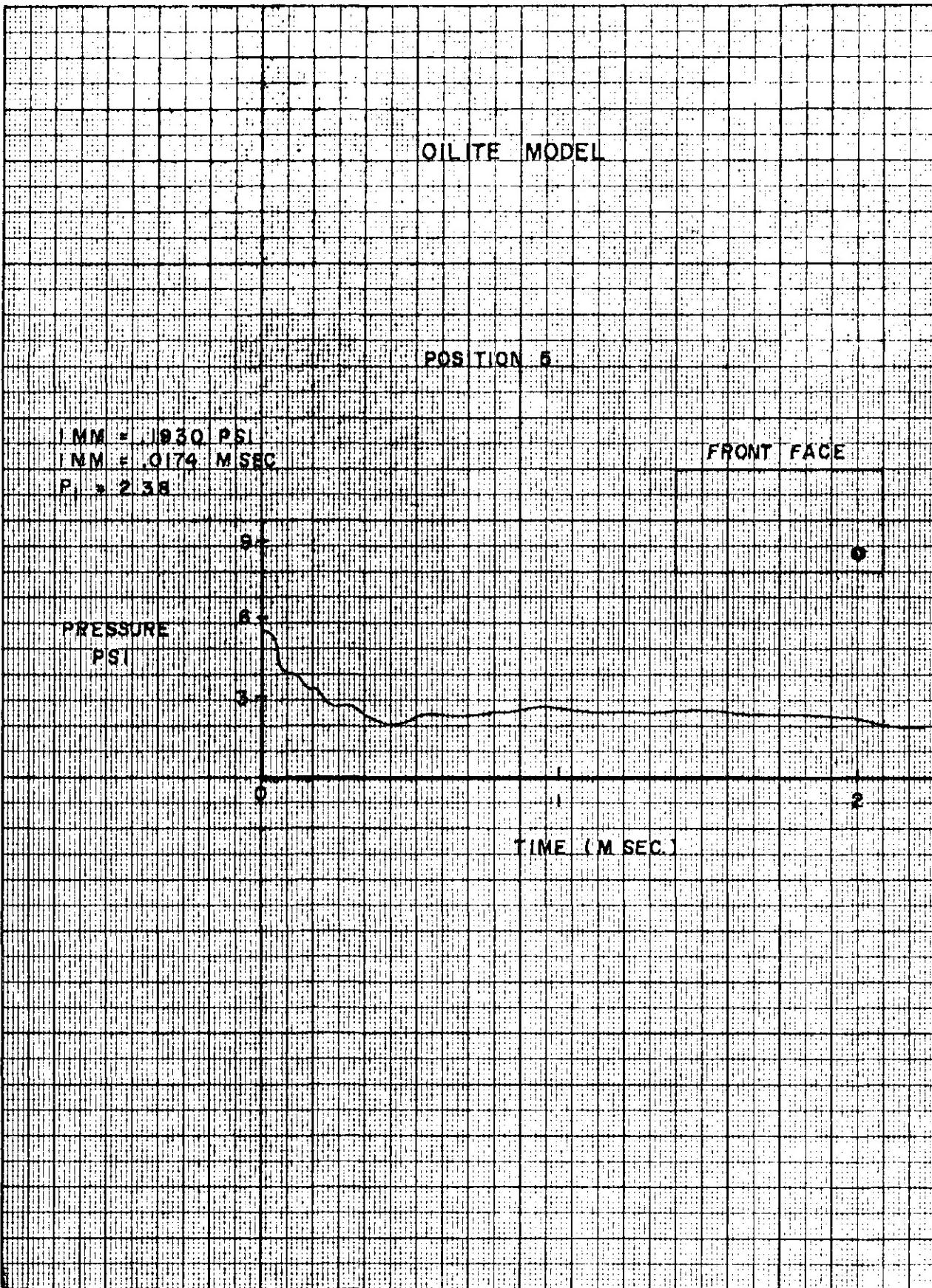
GAUGE POSITIONS 1 THRU 5

SKETCH I
OILITE MODEL

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OILITE MODEL

POSITION 1

BACK FACE

$P_{MM} = 1081 \text{ PSI}$

$t_{MM} = 0.170 \text{ M SEC.}$

$P_1 = 3.30$

PRESSURE

PSI

3

2

1

0

TIME (M SEC.)

POSITION 2

BACK FACE

$P_{MM} = 103 \text{ PS}$

$t_{MM} = 0.173 \text{ M SEC.}$

$P_1 = 3.30$

PRESSURE

PSI

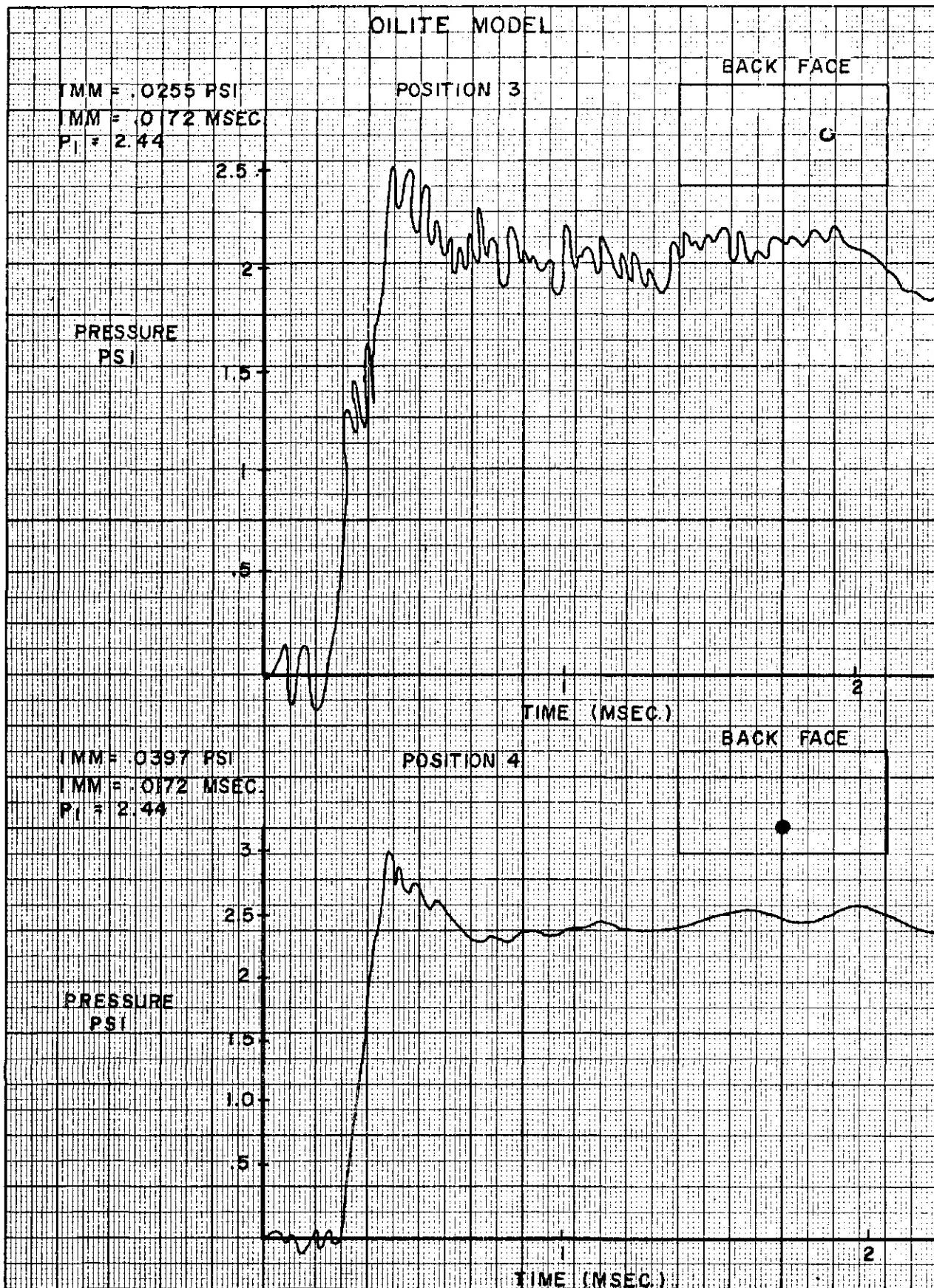
3

2

1

0

TIME (M SEC.)



O L T E MODEL

POSITION 5

BACK FACE

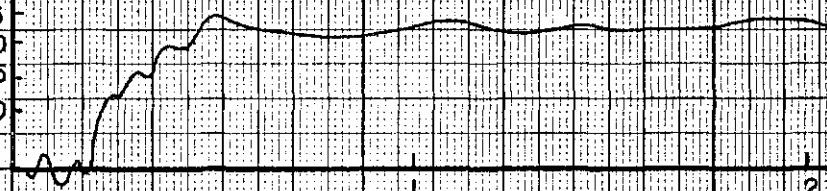
1 MM = 1118 PS

1 MM = 0.172 MSEC

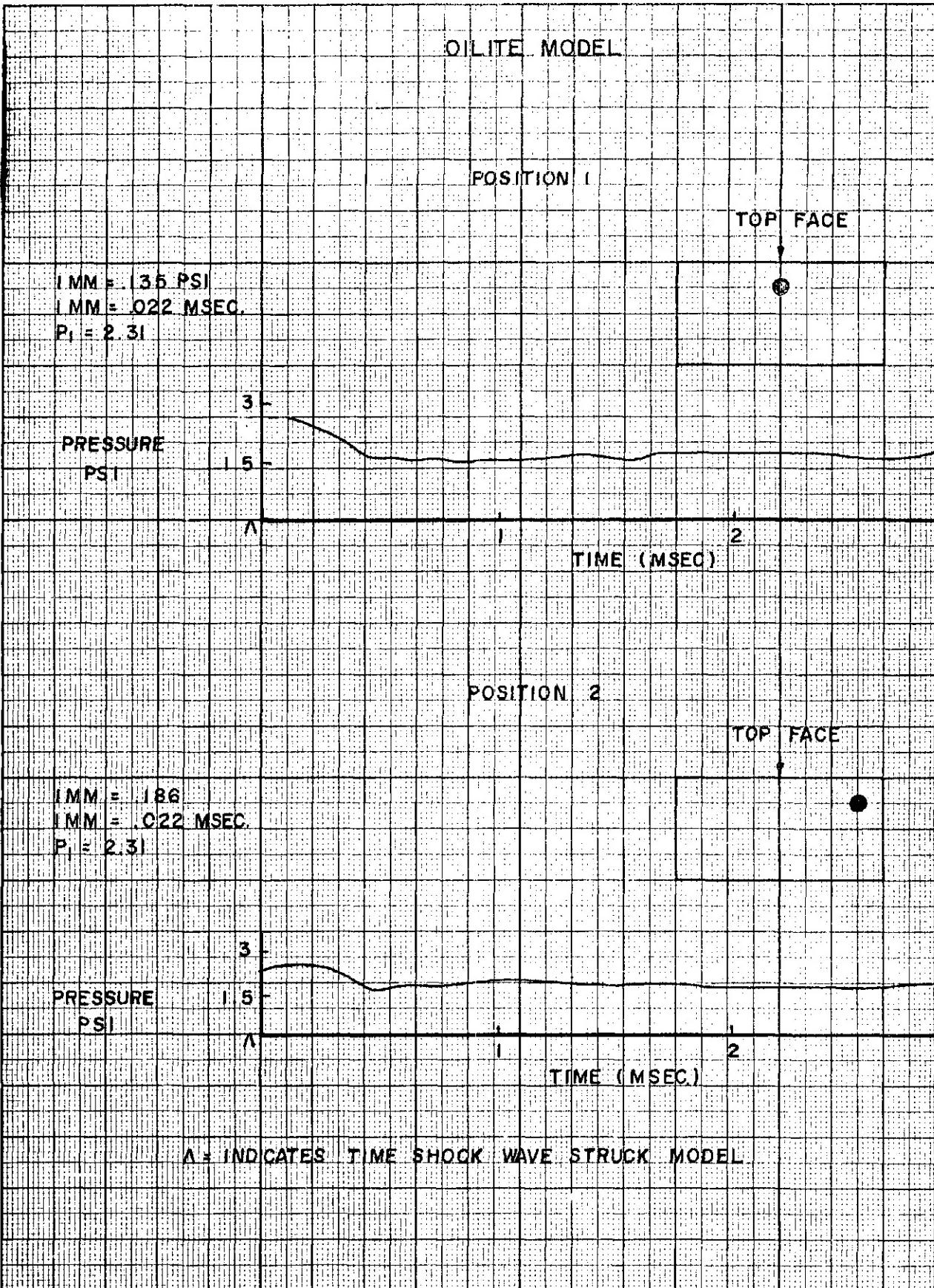
P₁ = 2.44

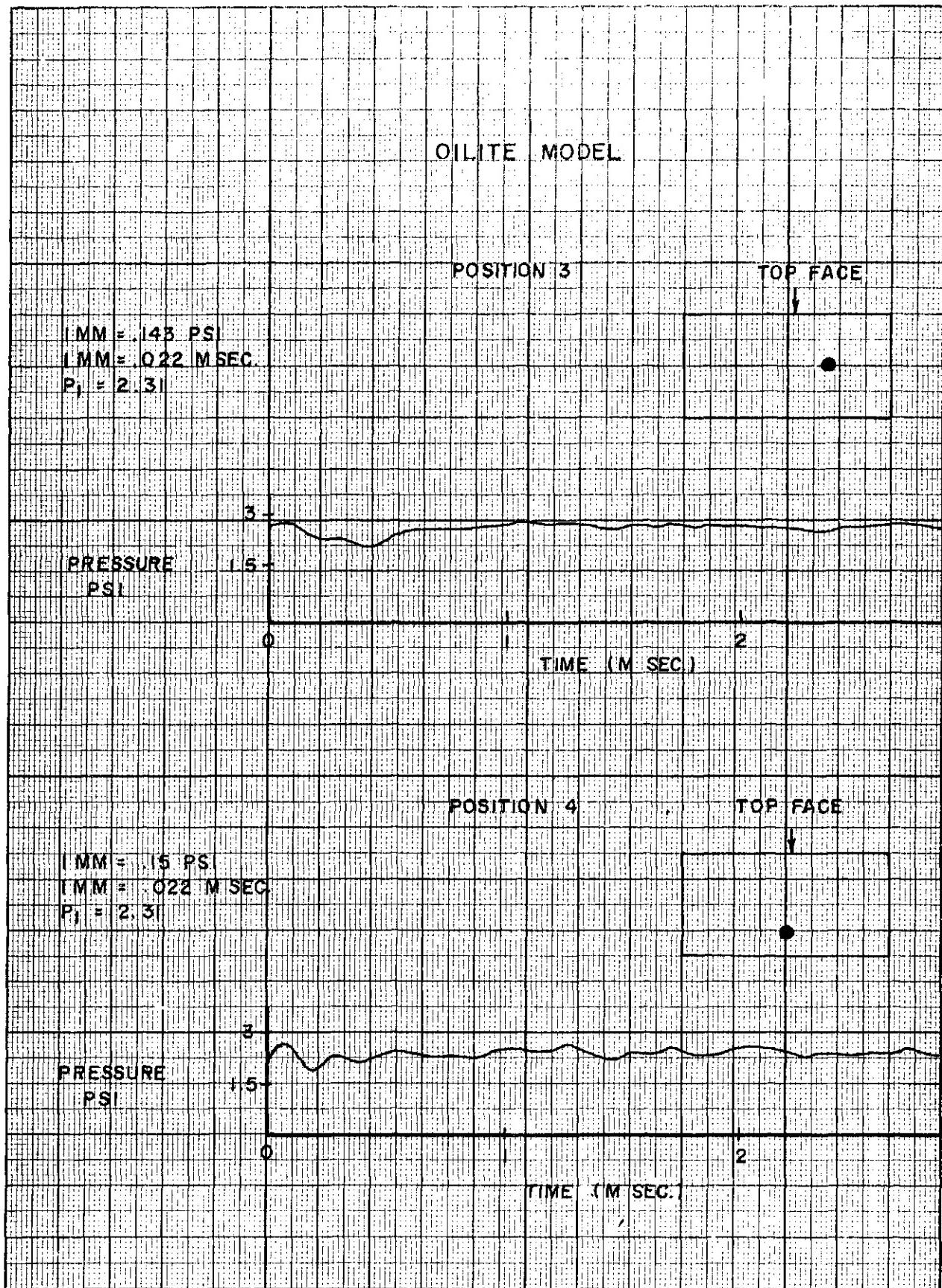
PRESSURE
PSI

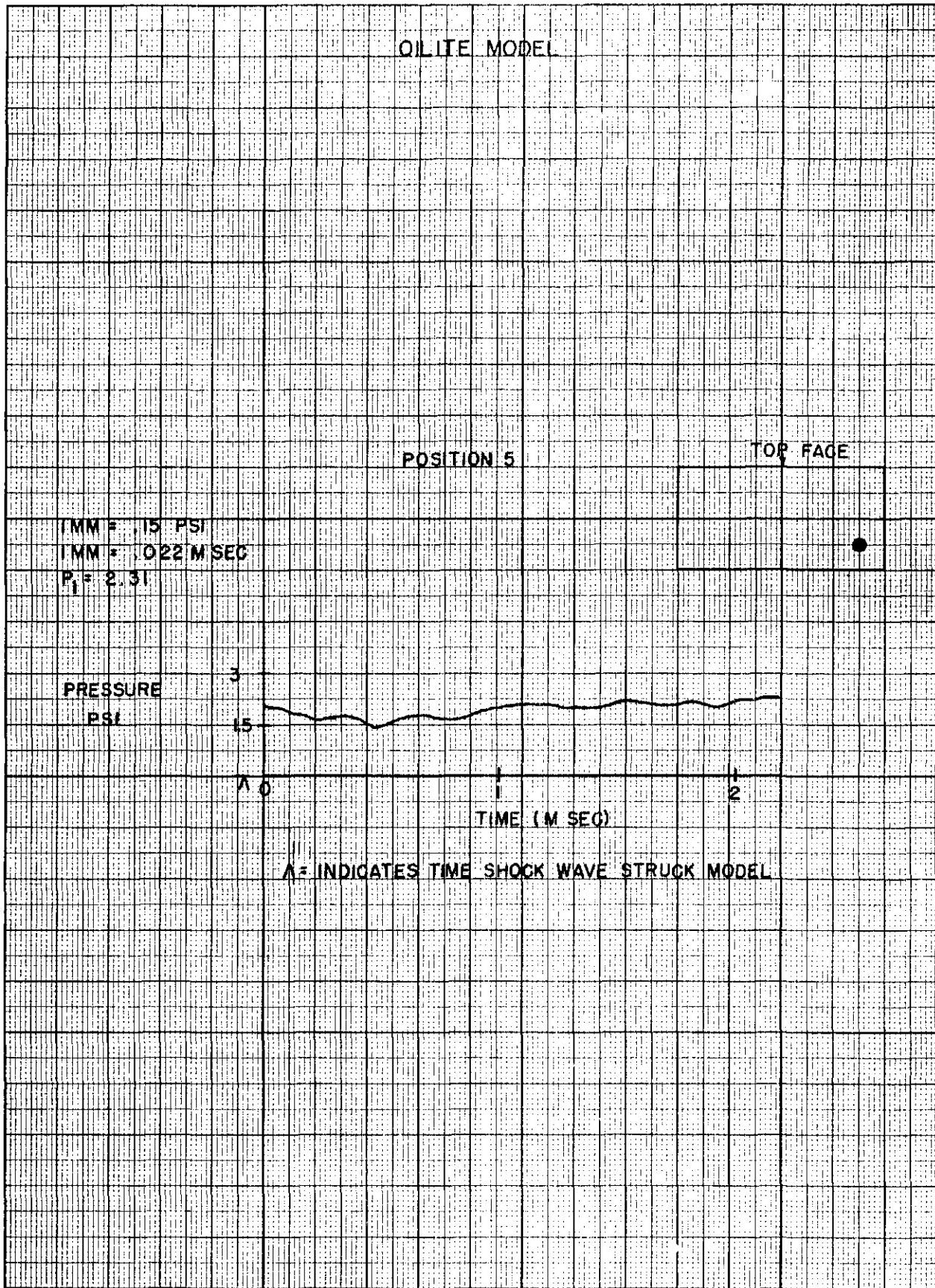
3
2.5
2.0
1.5
1.0

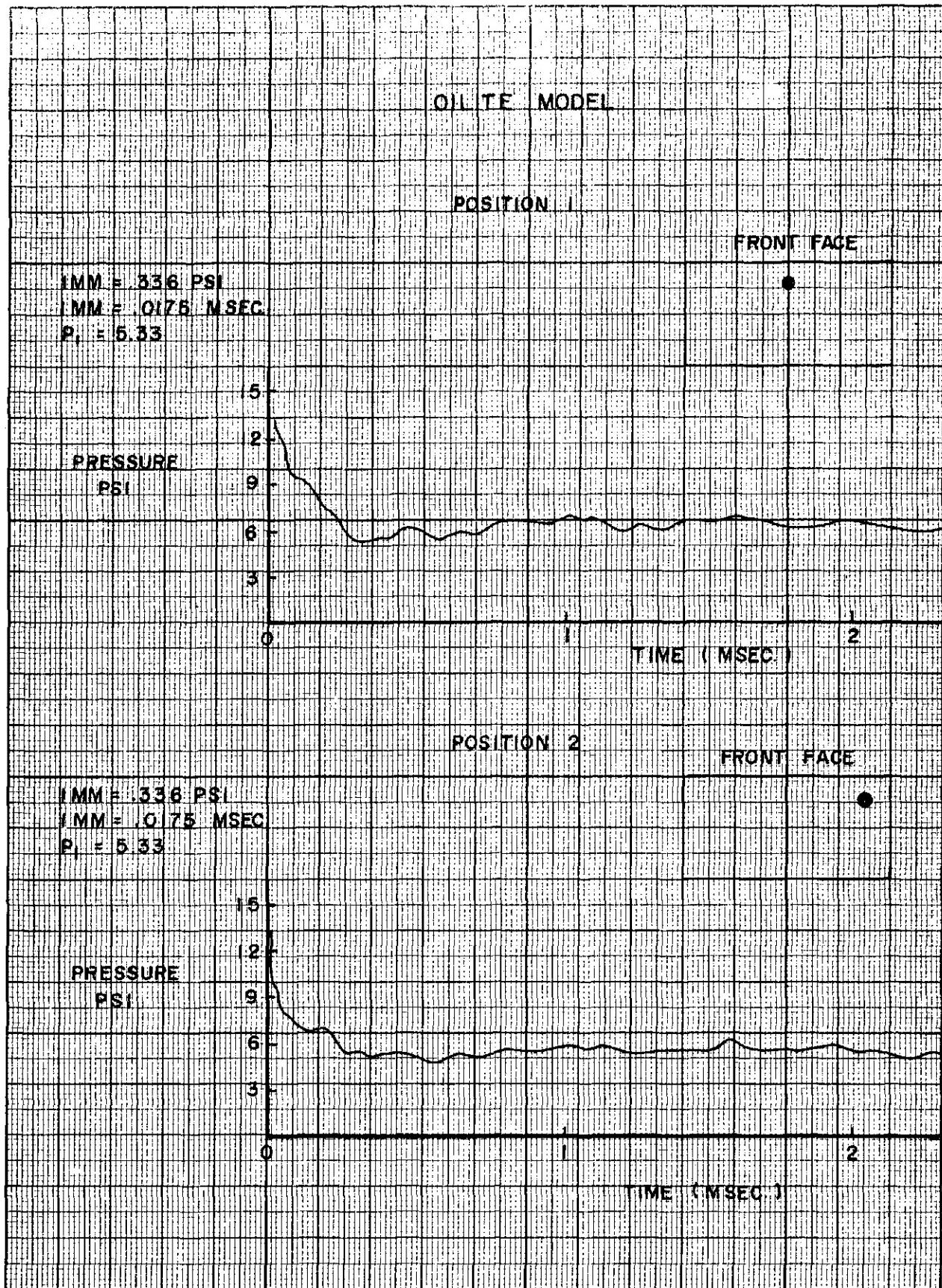


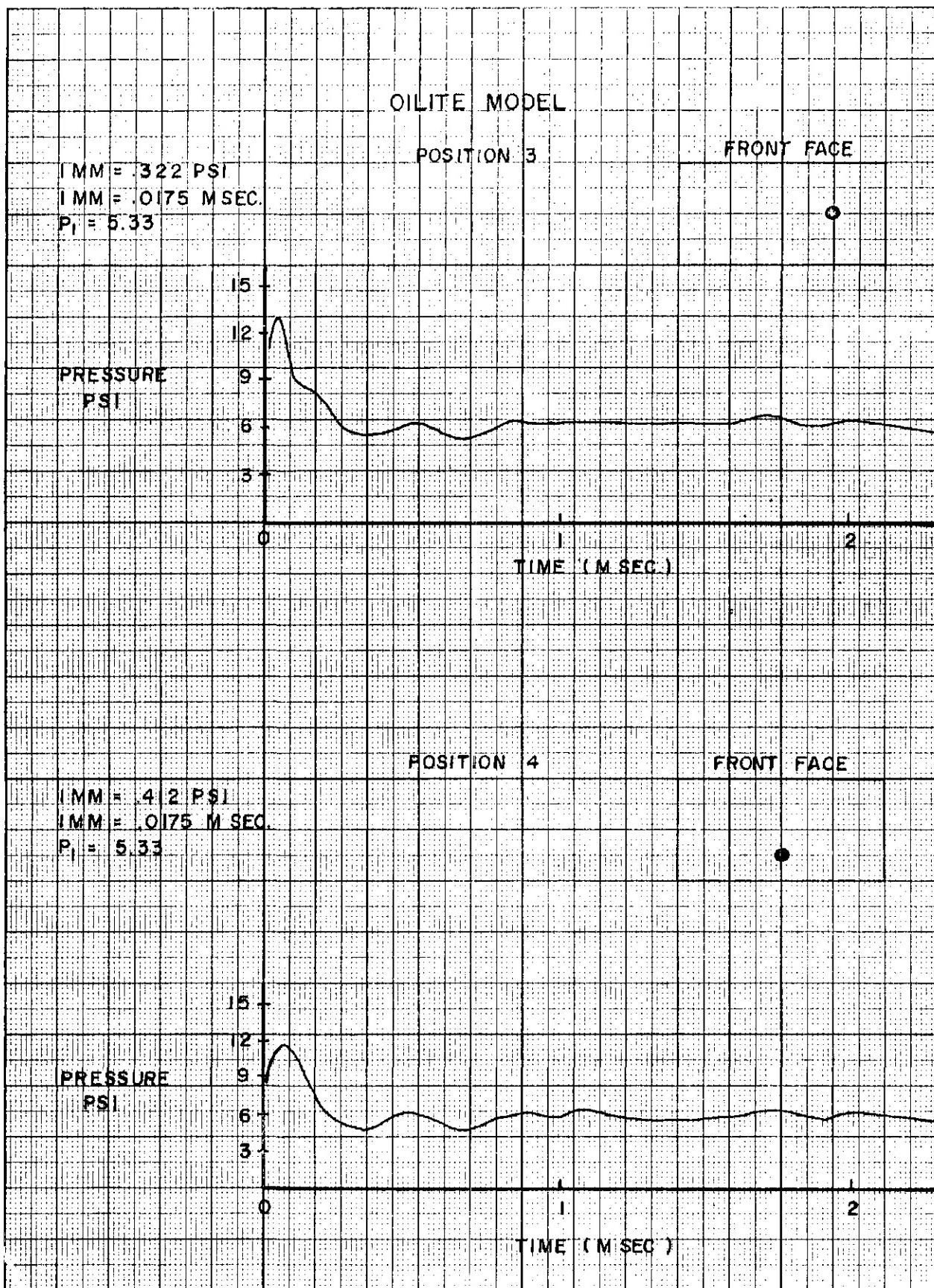
TIME (MSEC.)











OILITE MODEL

POSITION 5

FRONT FACE

MM = 4205 PS

IMM = 0.75

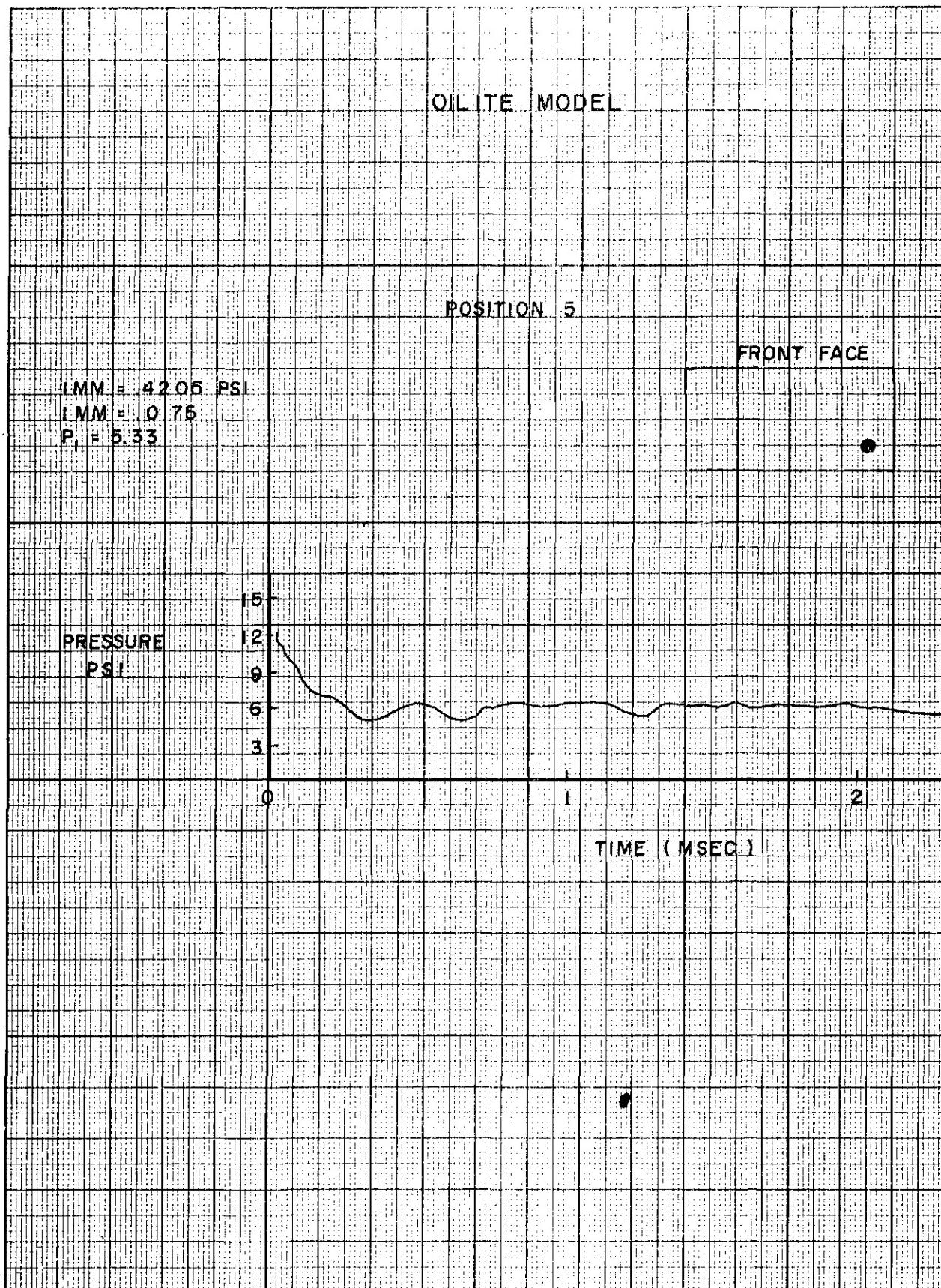
P. = 5.33

PRESSURE

PSI

12
10
8
6
4
2
0

TIME (MSEC)



OILITE MODEL

POSITION 1

BACK FACE

MM = .082 PSI

MM = .0174 SEC.

P₁ = 5.5

5 -

PRESSURE

PSI

3.75 -

2.5 -

1 TIME (MSEC) 2

POSITION 2

BACK FACE

MM = .0893 PSI

MM = .0172 SEC.

P₁ = P₂

5 -

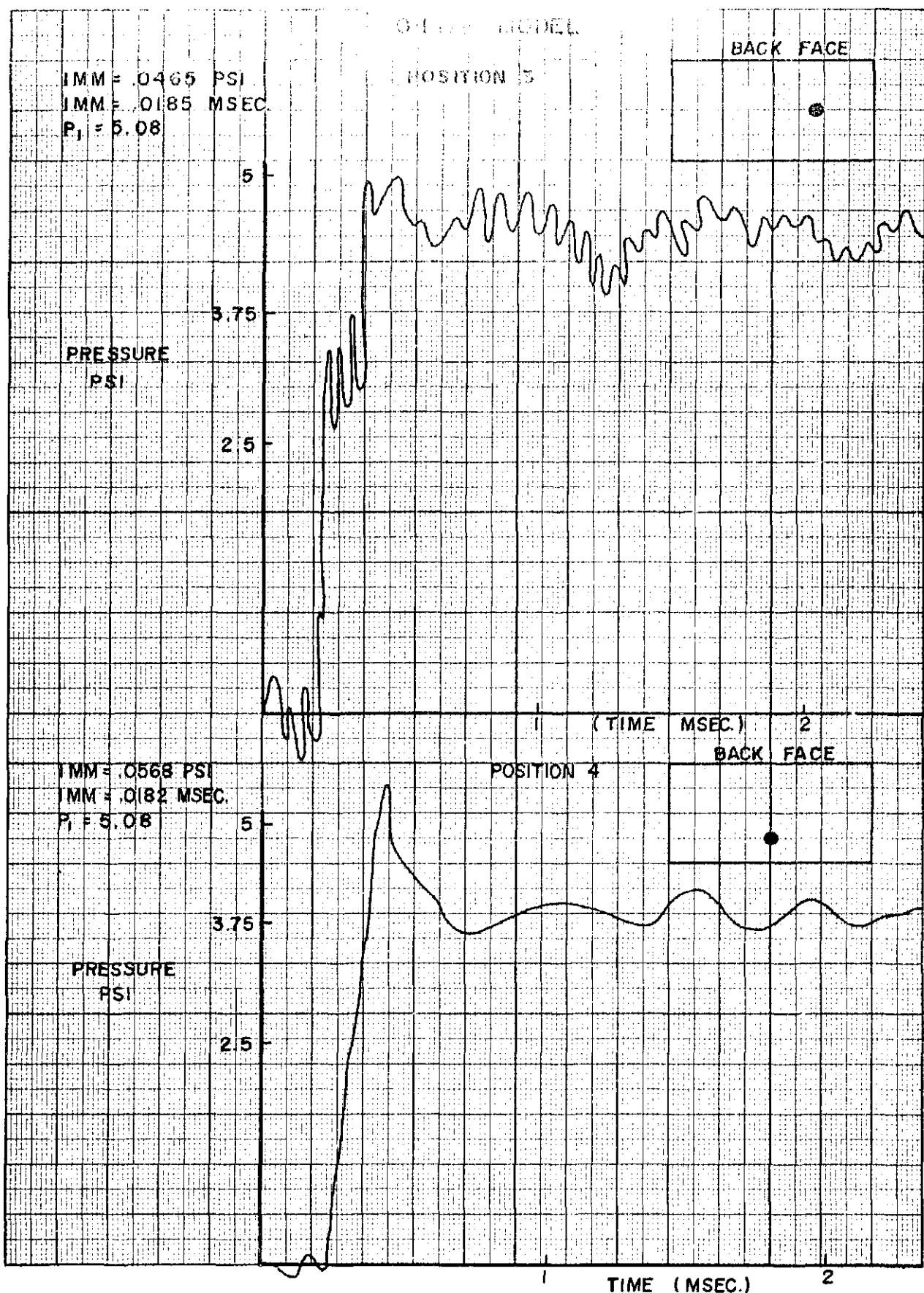
3.75 -

2.5 -

PRESSURE

PSI

1 TIME (MSEC) 2



OILITE MODEL

POSITION 5

BACK FACE

IMM = 112 PSI

IMM = 0.185 SEC.

P₁ = 5.08

5

3.75

PRESSURE

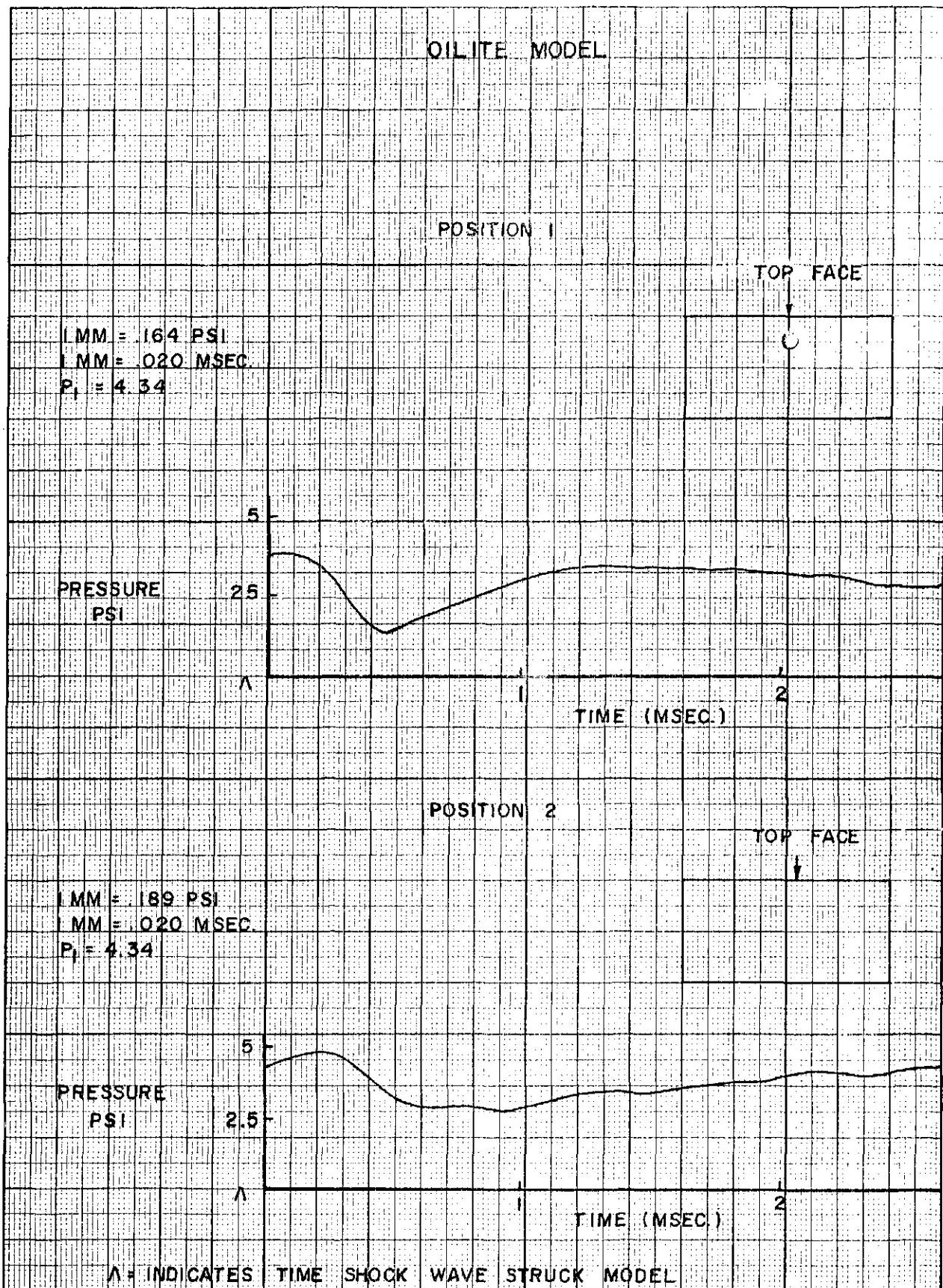
PSI

2.5

0

TIME (MSEC.)

2



OILITE MODEL

POSITION 3

TOP FACE

$$I_{MM} = 0.969 \text{ PSI}$$

$$I_{MM} = 0.20 \text{ M SEC}$$

$$P_1 = 4.34$$

PRESSURE

PSI

X O

1

2

TIME (M SEC)

POSITION 4

TOP FACE

$$I_{MM} = 117 \text{ PSI}$$

$$I_{MM} = 0.20 \text{ M SEC}$$

$$P_1 = 4.34$$

PRESSURE

PSI

X O

1

2

TIME (M SEC)

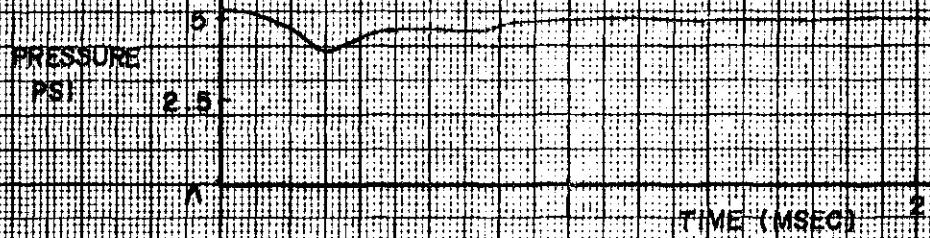
Δ = INDICATES TIME SHOCK WAVE STRUCK MODEL

OILITE MODEL

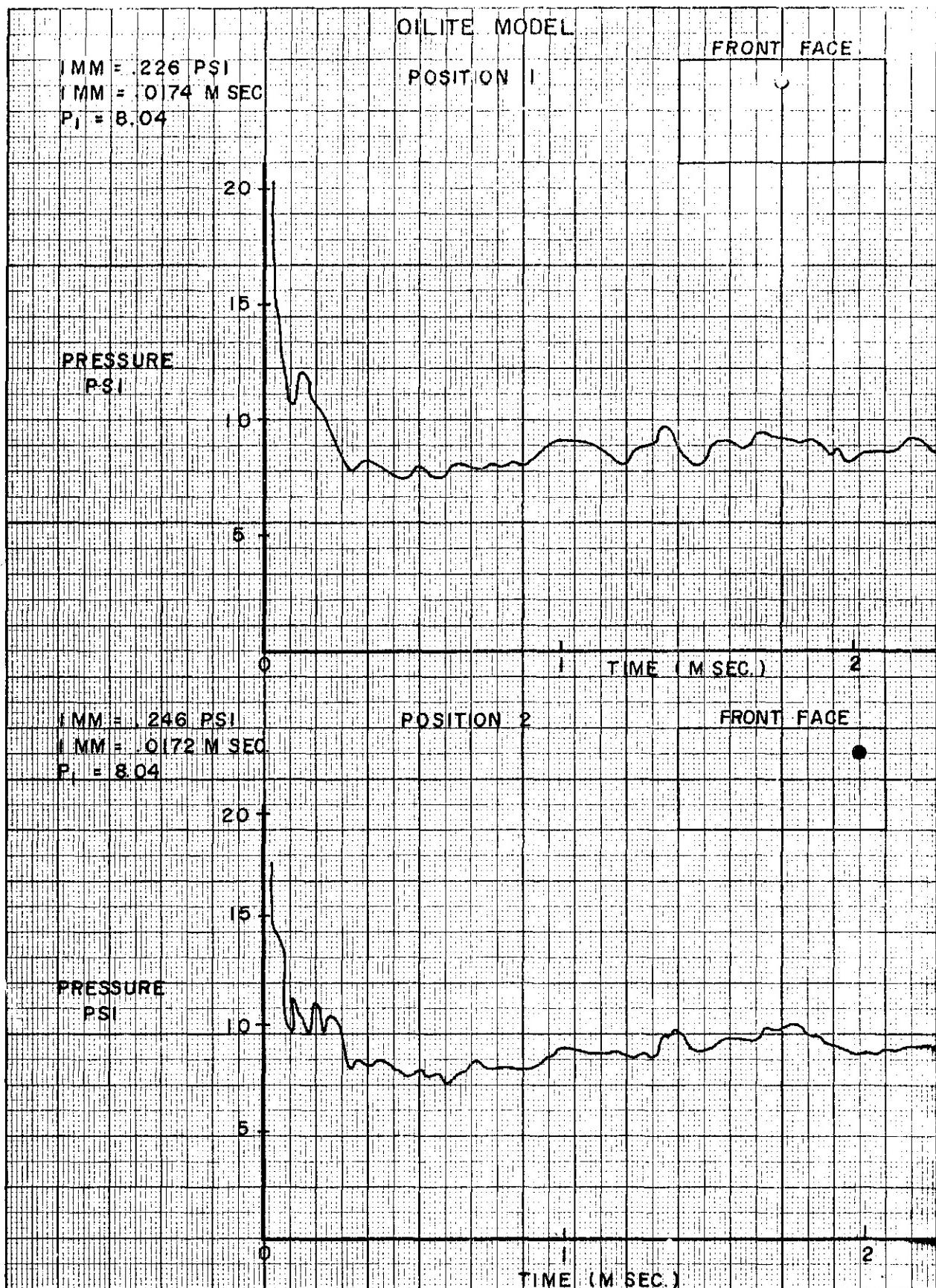
POSITION 5

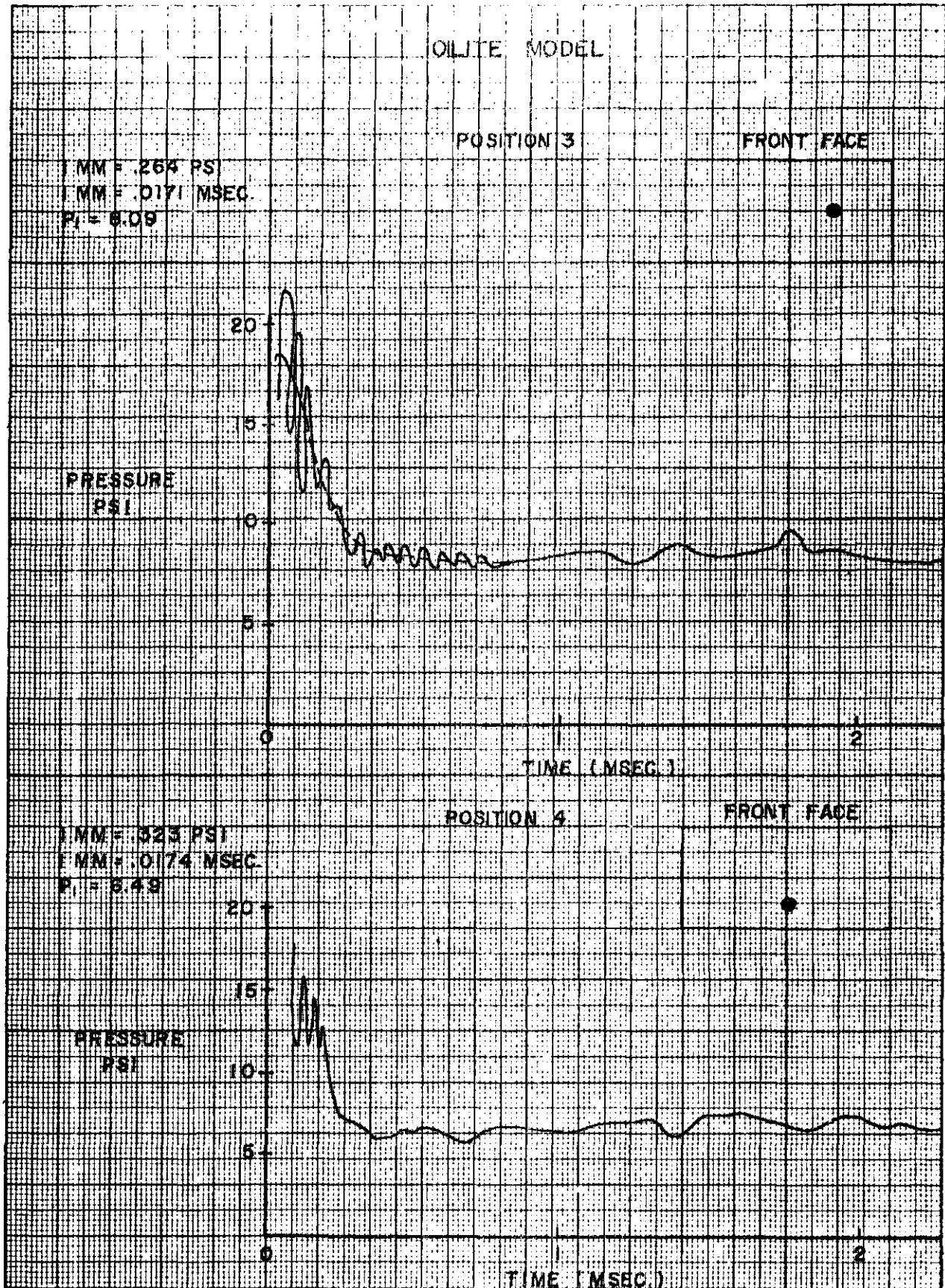
TOP FACE

1 MM = 148 PSI
1 MM = .022 MSEC.
C_L = 9.34



Δ = INDICATES TIME SHOCK WAVE STRUCK MODEL





O LITE MODEL

POSITION 5

IMM = 26 PSI

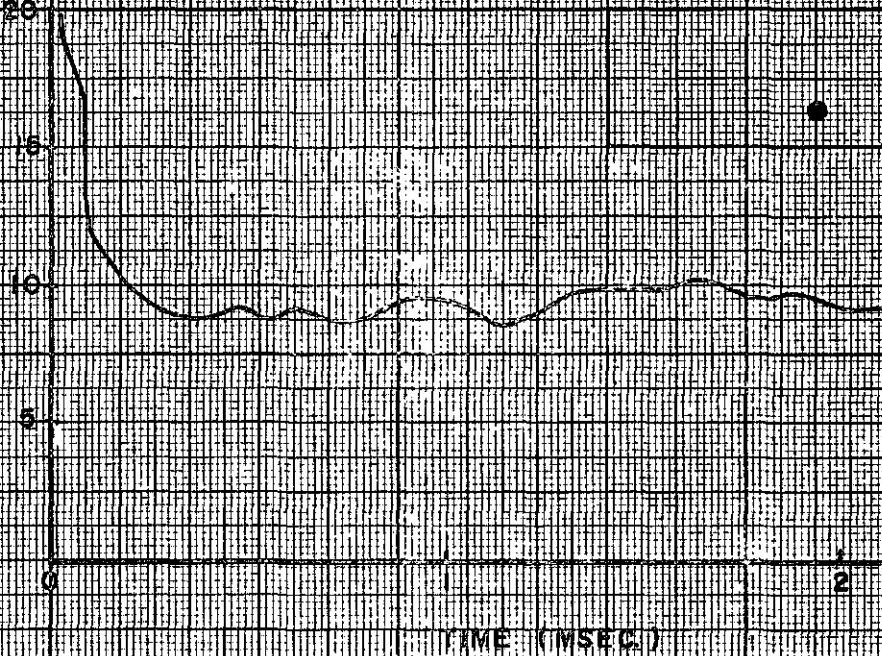
IMM = .0170 SEC.

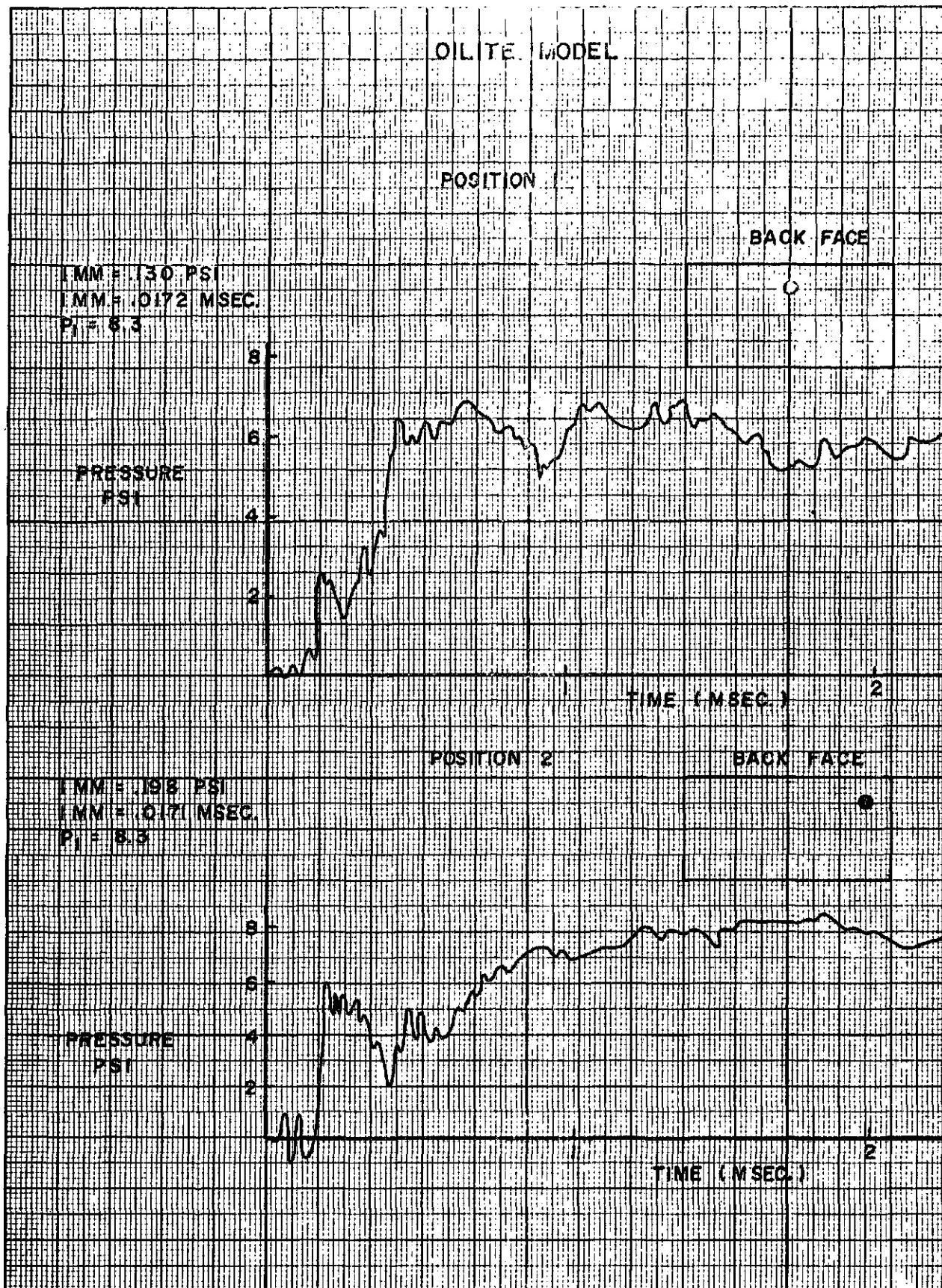
P_c = 0.30

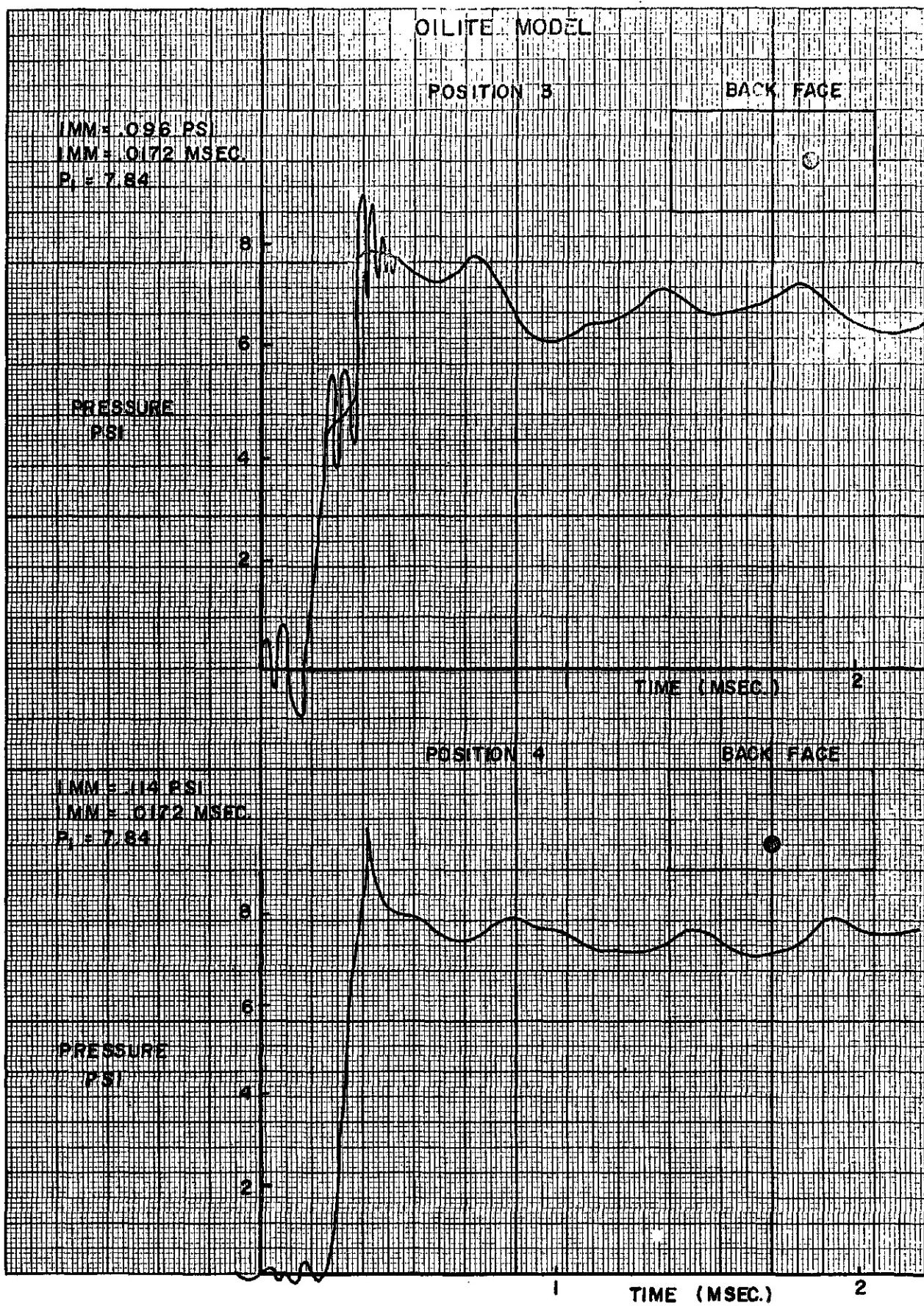
FRONT FACE

PRESSURE

PSI







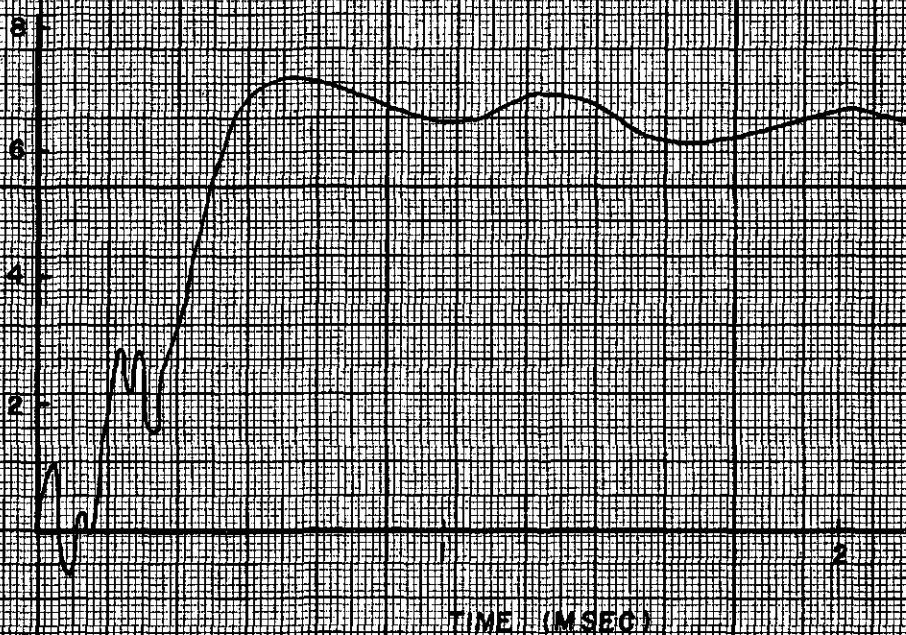
OILITE MODEL

POSITION 5

BACK FACE

$l_{MM} = 10 \text{ PSI}$
 $l_{MM} = .0172 \text{ MSEC}$
 $P_1 = 7.84$

PRESSURE
PSI



OILITE MODEL

POSITION 1

TOP FACE

$\Delta M = 161 \text{ PSI}$

$P = 9.01$

$\Delta MM = 0.22 \text{ MSEC}$

10

7.5

5

2.5

PRESSURE
PSI

0

2

TIME (MSEC.)

POSITION 2

TOP FACE

$\Delta M = 123 \text{ PSI}$

$\Delta MM = 0.22 \text{ MSEC}$

$P = 9.01$

10

7.5

5

2.5

PRESSURE
PSI

Δt INDICATES TIME

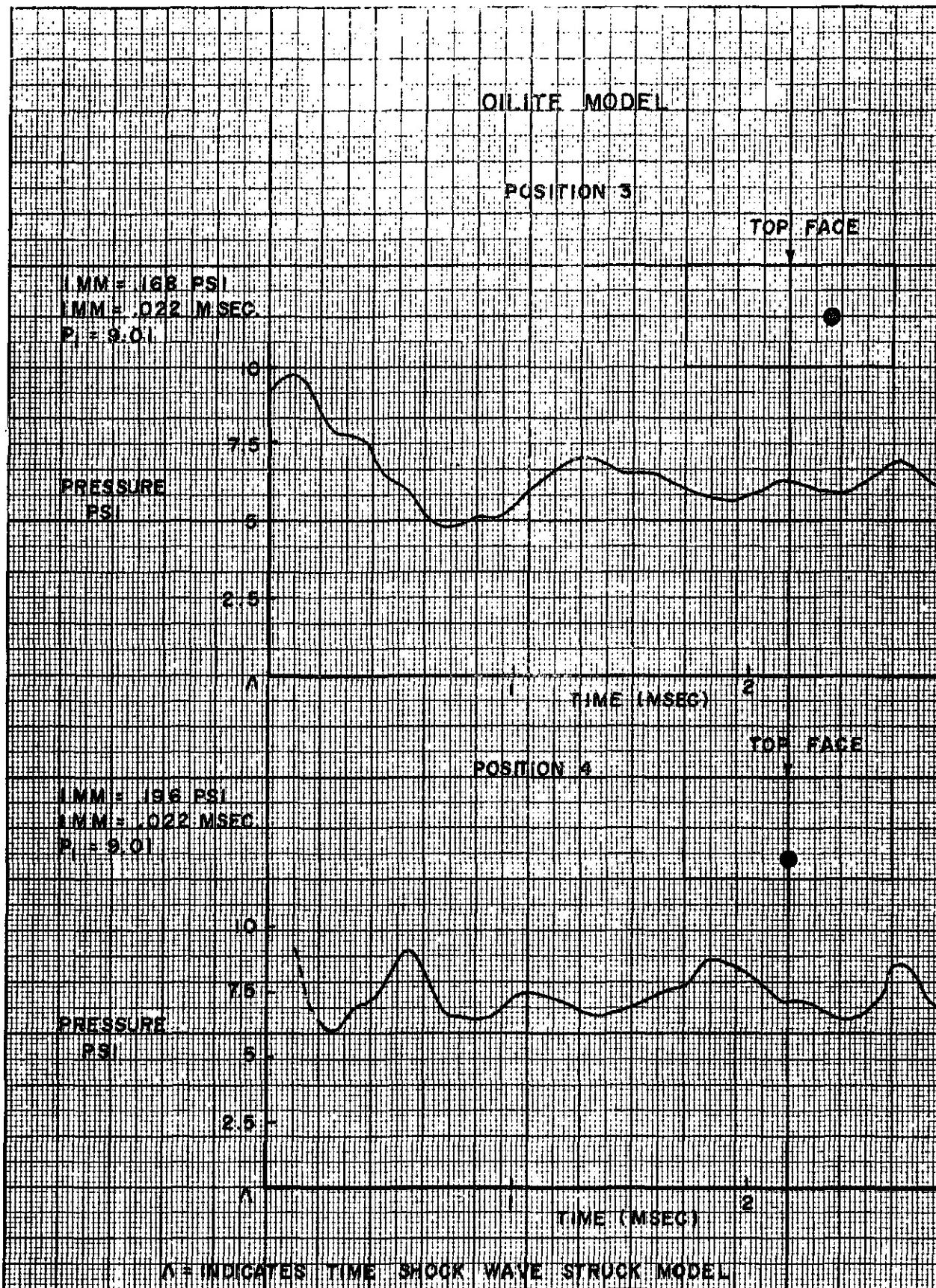
SHOCK WAVE

STRUCK MODEL

0

2

TIME (MSEC.)

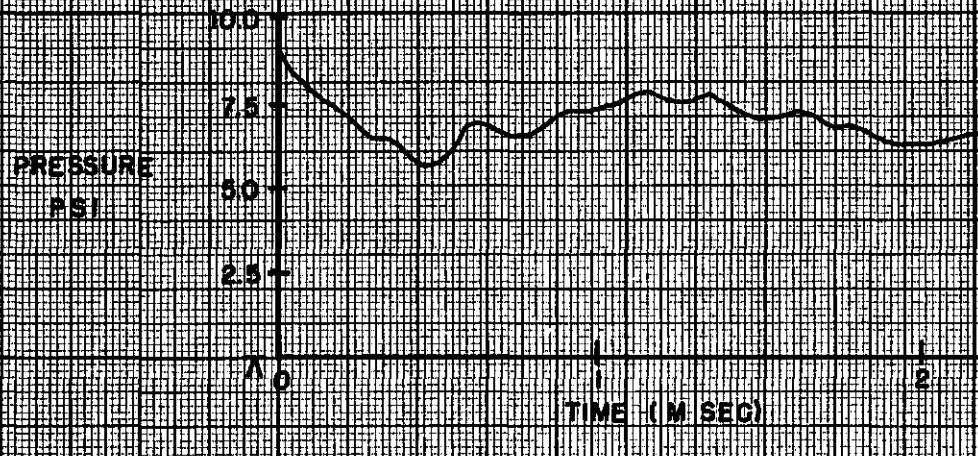


OILITE MODEL

POSITION 5

TOP FACE

$\text{MM} = 2038 \text{ PSI}$
 $\text{MM} = .1022 \text{ M SEC}$
 $P_0 = 9.0$



A - INDICATES TIME SHOCK WAVE STRUCK MODEL

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